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Canadian Biotechnology Industrial Activities: Features from the 1997 Biotechnology Survey

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CANADIAN BIOTECHNOLOGY INDUSTRIAL ACTIVITIES: FEATURES FROM THE 1997 BIOTECHNOLOGY SURVEY

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The Science and Innovation Information Program

The purpose of this Program is to develop **useful indicators of science and technology activity** in Canada based on a framework that ties them together into a coherent picture. To achieve the purpose, statistical indicators are being developed in five key entities:

- **Actors**: are persons and institutions engaged in S&T activities. Measures include distinguishing R&D performers, identifying universities that license their technologies, and determining the field of study of graduates.
- **Activities**: include the creation, transmission or use of S&T knowledge including research and development, innovation, and use of technologies.
- **Linkages**: are the means by which S&T knowledge is transferred among actors. Measures include the flow of graduates to industries, the licensing of a university's technology to a company, co-authorship of scientific papers, the source of ideas for innovation in industry.
- **Outcomes**: are the medium-term consequences of activities. An outcome of an innovation in a firm may be more highly skilled jobs. An outcome of a firm adopting a new technology may be a greater market share for that firm.
- **Impacts**: are the longer-term consequences of activities, linkages and outcomes. Wireless telephony is the result of many activities, linkages and outcomes. It has wide-ranging economic and social impacts such as increased connectedness.

The development of these indicators and their further elaboration is being done at Statistics Canada, in collaboration with other government departments and agencies, and a network of contractors.

Prior to the start of this work, the ongoing measurements of S&T activities were limited to the investment of money and human resources in research and development (R&D). For governments, there were also measures of related scientific activity (RSA) such as surveys and routine testing. These measures presented a limited picture of science and technology in Canada. More measures were needed to improve the picture.

Innovation makes firms competitive and we are continuing with our efforts to understand the characteristics of innovative and non-innovative firms, especially in the service sector that dominates the Canadian Economy. The capacity to innovate resides in people and measures are being developed of the characteristics of people in those industries that lead science and technology activity. In these same industries, measures are being made of the creation and the loss of jobs as part of understanding the impact of technological change.

The federal government is a principal player in science and technology in which it invests over $5 billion each year. In the past, it has been possible to say only *how much* the federal government spends and *where* it spends it. Our report **Federal Scientific Activities, 1998 (Cat. No. 88-204)** first published socio-economic objectives indicators to show *what* the S&T money is spent on. As well as offering a basis for a public debate on the priorities of government spending, all of this information has been used to provide a context for performance reports of individual departments and agencies.

As of April 1999, the Program has been established as a part of Statistics Canada's Science, Innovation and Electronic Information Division.

The final version of the framework that guides the future elaboration of indicators was published in December, 1998 (**Science and Technology Activities and Impacts: A Framework for a Statistical Information System,** Cat. No. 88-522). The framework has given rise to **A Five-Year Strategic Plan for the Development of an Information System for Science and Technology** (Cat. No. 88-523).

It is now possible to report on the Canadian system on science and technology and show the role of the federal government in that system.

Our working papers and research papers are available at no cost on the Statistics Canada Internet site at http://www.statcan.ca/cgi-bin/downpub/research.cgi?subject=193.

Working Papers

The Working Papers publish research related to science and technology issues. All papers are subject to internal review. The views expressed in the articles are those of the authors and do not necessarily reflect the views of Statistics Canada nor, in this case, the views of Industry Canada, Natural Resources Canada or the National Research Council of Canada.

TABLE OF CONTENTS

TABLE OF CONTENTS 5
ACKNOWLEDGEMENTS 6
EXECUTIVE SUMMARY 7
INTRODUCTION 9
II SURVEY METHODOLOGY AND DATA 9
2.1 Questionnaire Description 9
2.2 Questionnaire Administration 10
2.3 Data and Data Quality 10
III BIOTECHNOLOGY FIRMS DISTRIBUTION 11
3.1 Distribution by Firm Size 11
3.2 Distribution by Sector 11
3.3 Distribution by Province 11
IV REVENUES AND R&D EXPENDITURES 14
4.1 Number of Biotechnology Firms Reporting Biotechnology Revenues 14
4.2 Total Revenues and Biotechnology Revenues 15
4.3 Total R&D Expenditures and Biotechnology Expenditures 16
V EXPORTS ACTIVITIES 18
5.1 Number of Biotechnology Firms Declaring Exports and Biotechnology Exports 18
5.2 Total Export Revenues and Biotechnology Export Revenues 19
VI PRODUCTS PIPELINE 21
6.1 Number of Biotechnology Products by Sector, by Firm Size, by Province and by Stage of Development 21
6.2 Number of Products by Sector, Firm Size and Province and by Sector and Firm Size 24
VII HUMAN RESOURCES 26
7.1 Total Employment by the Biotechnology Firms 26
7.2 Biotechnology Employment 26
VIII OBSTACLES TO BIOTECHNOLOGY COMMERCIALIZATION 28
8.1 Main Biotechnology Commercialization Obstacles 28
8.2 Obstacles to Biotechnology Commercialization by Sector, Firm Size and Province 28
IX PURPOSES OF RAISING FINANCING CAPITAL AND ITS SOURCES 30
9.1 Purposes of Raising Financing Capital 30
9.2 Sources of Financing Capital 31
X SOCIAL CAPITAL: NETWORKING ACTIVITIES 32
10.1 Strategic Alliances and Origin of Partners 32
10.2 R&D Partnerships and Origin of Partners 32
References 34
Annex 1 – Questionnaire 35
How to Order Catalogued Publications 36

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The survey also owes a debt of gratitude to the firms, that must remain anonymous, for the time given to respond to the survey.

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EXECUTIVE SUMMARY

As of 1997, the core of Canadian biotechnology consisted of 282 biotechnology firms. Of these, 76% were small firms. The majority, 48%, were in the health sector. Quebec and Ontario together were home to 59% of them. They brought in $14 billion in total revenues. Of these, $813 million came from biotech sales. In total, they exported for over $3 billion in products. Nine percent of that amount, i.e. $311 million are from biotech products exports. The total number of products at all stages of development was 8,924. Twenty percent of that number represented products approved or on the markets, 41% were products in the clinical/field trial and, 39% were under development. Total employment by firms was estimated at about 32,000 people with over 9,000 people working in biotechnology. The main hurdle to biotech commercialization was access to capital. Thirty nine percent (39%) of the biotech firms raised financing capital in the 1997 year. For that, they heavily relied on private placements and venture capital and labor sponsored funds. Networking was an important activity, with marketing and distribution being the major reason for which strategic alliances were established. Over half of the biotech firms had R&D partnerships with universities.

Comparisons by firm size show that 49% of biotech sales are made by large firms as compared to 26% for small firms and 25% for medium-sized. Small firms outspent other firm categories in R&D: $193 million versus $177 million for large firms and $124 million for medium sized firms. Large firms account for 54% of biotech export revenues while medium firms have the largest number of products, 70%, at all development stages. Large firms account for 42% of biotech employment.

Sectoral comparisons show that the health sector is dominant in many respects. It accounts for 48% of all the firms, over half of the biotech sales, 79% of total R&D expenditures, 83% of biotech R&D expenses and 57% of the biotech sales. The agriculture and the food processing sector accounts for 62% of total revenues but only 32% of biotech revenues. This sector accounts for 41% of all the products and over 86% of all the products at the clinical/field trial stage.

Regional comparisons show that Ontario is home to 31% of the Canadian core biotech firms followed by Quebec at 28% and British Columbia at 18%. Firms in Ontario account for 45% of biotech revenues as compared to 28% for those in Quebec. Firms in Quebec outspent those in Ontario in overall R&D: $383 million versus $363 million. However, firms in Ontario spent the most in total R&D: $220 million as compared to $132 million in Quebec and $77 million in British Columbia. The province of Ontario is responsible for 49% of biotech revenues. Quebec has over 65% of all the products and 84% of the products in the clinical/field trial stage. Ontario, on the other hand, accounts for over a third of biotech employment, followed by Quebec at 30%.

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INTRODUCTION

Biotechnology activities in recent years have not only attracted attention in the media, but have also become a larger part of the Canadian economy in terms of the number of firms, the amount of revenues generated and, the amount of R&D expenses (Rose 1998, Arundel 1999, Arundel and Rose 1999, McNiven 2001 a, b, Niosi 2000). For example, McNiven (2001 a) found that the number of biotechnology firms was 358, an increase of 21% over 1997. Biotech revenues were estimated at $1.5 billion in 1998 and at $1.9 billion in 1999. Biotechnology R&D expenditures amounted to $695 million and $827 million in 1998 and 1999, respectively (McNiven 2001a). Hence, The Life Science section of the Science, Innovation and Electronic Information Division (SIEID) of Statistics Canada works on the developments of new improved indicators, the gathering of reliable data on biotechnology, the publishing of research and working papers on the topics as well participating in different committees at the national and international levels.

This working paper presents new estimates for the Biotechnology Firm Survey of 1997. The new estimates are meant to harmonize data from the 1997 and 1999 biotechnology firm survey. The data are based on a questionnaire (described below) sent out to 475 firms believed to be involved in biotechnology. In 1997, it is estimated that the core activities of biotechnology was composed of 282 biotechnology firms.

This paper is organized as follows: This introduction is followed by a second section describing the questionnaire, its administration, the data and their quality. The third section looks into the distribution of the biotech firms by province, sector and firm size. The fourth section is concerned with revenues and R&D expenses. The export activities are the focus of the fifth section, and the sixth deals with the products pipeline. Human resources are the topic of the seventh section. Section 8 looks into the hurdles faced by biotech firms in selling their products. Section 9 deals with financing capital: the purposes for raising it and its origins. The last section looks into the networking activities of the surveyed firms.

II SURVEY METHODOLOGY AND DATA

2.1 Questionnaire Description

In the 1997 Biotechnology Firm Survey, biotechnology is defined "*as the application of science and engineering in the direct or indirect use of living organisms or parts of organisms in their natural or modified forms in an innovative manner in the production of goods and services or to improve existing processes*". To define biotechnology in a more precised manner, the questionnaire used a list based on three

categories of biotechnologies: DNA based, Biochemistry/immunochemistry based and bioprocessing based[1].

The questionnaire was designed in 10 main sections by Statistics Canada in partnership with Industry Canada and BioteCanada. It aimed to collect data on and document i) the use of biotechnology by the Canadian industry sector, ii) the scope of biotechnology activities in terms of the number of products at different development stages, iii) financial assets of the biotech firms, iv) R&D activities, v) strategic partnerships, vi) employment in the sector, vii) intellectual property (IP) instruments, viii) biotech commercialization problems in Canada, ix) access to financing capital, and x) strategic decisions biotech firms' CEOs made in the 1997 year or planned to make in 1998.

2.2 Questionnaire Administration

The questionnaire was administered by Statistics Canada in the summer of 1998. It was mailed to 475 firms whose names and addresses were obtained from Industry Canada, the 1998 Canadian Biotechnology Directory maintained by Contact Canada, and the Statistics Canada Industrial R&D survey.

Of the 475 firms that were sent the questionnaire, 150 were out of scope, 44 were out of business, 72 couldn't be reached or refused to answer the questionnaire and 210 provided the requested data.

The size of the Canadian Biotech sector was estimated to be 282 firms. This figure is obtained by way of weighing and imputation, taking into account the weight of the sector and province and each firm size category in the sample at hand.

2.3 Data and Data Quality

The data used in the current report are based on the 282 firms that constituted the Canadian Biotech sector in 1997.

Excluded from the survey were not-for-profit organizations, universities, government laboratories, hospitals, newly established firms and companies that use only traditional biotechnological techniques, dairy culture or fermentation. The current report does not cover any consolidations or bankruptcies or new entrants into the sector that occurred after June 1998. These exclusions are not expected to create any major bias in the results. Indeed, companies that use traditional biotech techniques and newly created companies constitute a small percentage of the biotech universe. In addition, universities, government laboratories and hospitals even though very active in R&D and may have given rise to new spin-off biotech companies, are not considered as belonging to the biotech industrial activities.

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[1] Details of the elements that make each of these categories are found in the second question of the questionnaire annexed to the current report.

Comparison with data from other sources, for example Ernest and Young and Contact Canada, from the same period show similar trends in the major indicators: R&D activities, level of employment, firm size, and revenue levels[2].

III BIOTECHNOLOGY FIRMS DISTRIBUTION

3.1 Distribution by Firm Size

From the 1997 biotech survey, it is estimated that 282 biotechnology firms[3] constituted the core of the Canadian biotechnology activities. Of these, about 76% are small firms, i.e. firms with 50 employees or less, 13% are medium-sized, 51 to 150 employees and 11% are large with more than 150 employees (Table 1).

3.2 Distribution by Sector

The definitions of the three sectors and the Other sector used in this study are found in Table 2. The distribution by sector shows that the health sector far outweights the other sectors. In fact a little over 48% of the core biotechnology firms belong to that sector. It is followed in decreasing order by the agricultural and food processing sector at 26%, the Other sector at about 15%, and the environment at 11% (Table 1).

3.3 Distribution by Province

The distribution of Canadian biotechnology firms shows that Ontario and Quebec are the prime locations, with 31% and 28% of the firms, respectively. Eighteen percent are located in British Columbia. Alberta and Saskatchewan are each home to about 7% of biotechnology firms (Table 1). The Maritimes provinces, P.E.I., Nova Scotia, New Brunswick, and Newfoundland account for a little over 7% of the firms.

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[2] Canadian Biotech 1997: Coming of Age, Ernest & Young, John Goudey and Deepika Nath, 1997 and Canadian Biotechnology 1998, Contact Canada, Fred Haynes, 1998.

[3] In the 1997 biotechnology firm survey, a biotechnology firm is a firm that uses biotechnology and undertakes R&D in biotechnology. In the 1999 survey, a biotech firm is also one that develops products and processes that use biotechnology.

Table 1: Biotechnology Firms Distribution According to the Firm Size, the Sector and the Province, 1997

Number of Biotechnology Firms According to the Firm Size	
	Number of Firms
Small Firms (50 or less employees)	214
Medium Firms(51-150 employees)	37
Large Firms (over 150 employees)	31
Total	**282**

Number of Biotechnology Firms According to the Sector	
	Number of Firms
Health	136
Agriculture and Food Processing	74
Environment	31
Other	41
Total	**282**

Number of Biotechnology Firms According to the Province	
	Number of Firms
British Columbia	52
Alberta	19
Saskatchewan	19
Manitoba	6
Ontario	87
Quebec	79
Maritimes	20
Canada	**282**

Source: Statistics Canada

Table 2: Definition of the sectors

SECTORS	COMPONENTS
HEALTH (HUMAN)	♦ Diagnostics ♦ Therapeutics ♦ Gene therapy
AGRICULTURE AND FOOD PROCESSING	♦ Plant Biotechnology ♦ Animal Biotechnology ♦ Biofertilizers/Biopesticides/Bioherbicides/ Biological Feed Additives/Microbial Pest Control ♦ Non-Food Applications of Agricultural Products ♦ Bioprocessing ♦ Functional Foods/Nutriceuticals
ENVIRONMENT	♦ Biofiltration ♦ Bioremediation and Phyto/Plant/remediation ♦ Diagnostics
OTHER	♦ Genomics and Molecular Modeling ♦ Fish Health ♦ Broodstock Genetics ♦ Bioextraction ♦ Microbiologically Enhanced Petroleum/ Mineral Recovery ♦ Industrial Bioprocessing ♦ Custom Synthesis-Chemical or Biological

Source: The 1997 biotechnology survey questionnaire

IV REVENUES AND R&D EXPENDITURES

4.1 Number of Biotechnology Firms Reporting Biotechnology Revenues

As Table 3 shows, 237 out of 282 or 84% of core biotechnology firms declared some revenues in 1997. Of these, 178 are small firms, 29 are medium sized and 30 are large firms. In other words, 83% of small firms earned some revenues in 1997 as compared to 78% of medium-sized and 97% of large firms.

One hundred and fifteen (115) of the firms that declared some revenues in 1997 are in the health sector, 64 in agriculture and food processing, 26 in environment and 32 in the Other sector. Thus, roughly 85% of all the firms in the health sector earned some revenues. That percentage was 86% for the agriculture and food processing sector, 84% for the environment sector and 78% for the Other sector.

Most of the firms that declared revenues were in Ontario and Quebec, 69 and 65 firms respectively. British Columbia was home to 43 of them, with 41 located in the prairies and 19 in the Maritimes (Table 3).

A combination of factors may explain why some 45 firms did not report any revenues. First of all, it takes a long time for R&D results to materialize into actual products and processes. Second, there is often a long testing process before biotechnology products may be allowed on the market. Several small firms have not yet reached the market, therefore not reporting any revenues.

Table 3: Number of Biotechnology Firms Declaring Revenues and Biotechnology Revenues by Firm Size, by Sector and by Province, 1997

Size, 1997	Number of Firms Declaring Revenues	Number of Firms Declaring Biotechnology Revenues
Small Firms (50 employees or less)	178	134
Medium Firms (51-150 employees)	29	24
Large Firms (over 150 employees)	30	18
Total	**237**	**176**

Sector, 1997	Number of Firms Declaring Revenues	Number of Firms Declaring Biotechnology Revenues
Health	115	78
Agriculture and Food Processing	64	41
Environment	26	25
Other	32	32
Total	**237**	**176**

Province, 1997	Number of Firms Declaring Revenues	Number of Firms Declaring Biotechnology Revenues
British Columbia	43	32
Alberta	19	14
Saskatchewan	17	12
Manitoba	5	4
Ontario	69	49
Quebec	65	48
Maritimes	19	17
Canada	**237**	**176**

Source: Statistics Canada

4.2 Total Revenues and Biotechnology Revenues

The 282 biotechnology firms brought in over $14 billion in total revenues in 1997. Of these, $12 billion, i.e. 83% of total revenues, were made by large firms, $685 million by medium firms and, $1.7 billion by small ones (Table 4).

The sectoral distribution of the revenues show that the agriculture and food processing sector earned almost $10 billion in 1997, i.e. 68% of total revenues. It is followed in decreasing order by the health sector at $3.4 billion and the environment sector at $1 billion (Table 4).

Firms in Saskatchewan were the largest revenue earners with $5.6 billion. The other important provinces are Quebec with 3.8 billion, Ontario, with $2.7 billion and Manitoba, with almost $2 billion. Firms in the four Maritime provinces brought in $61 million in

revenues, placing them behind British Columbia ($118 million) and Alberta ($248 million) (Table 4).

Of the $14 billion earned in 1997, $813 million came from biotechnology products sales. Forty nine percent (49%) or $398 million were made by large firms, as compared to 26% ($214 million) by small firms and 25% ($201 million) by medium firms. A little over half of the biotechnology revenues, $417 million, came from the health sector. About 40% or $322 million were made by firms in the agriculture and food processing sector. Environment and the Other sectors were the least revenue earners with $49 million and $25 million, respectively (Table 4).

Ontario accounted for about 45% of the 1997 biotechnology revenues as compared to about 28% for Quebec. Together, firms in these two provinces accounted for over 72% of biotechnology revenues. Firms in the prairies earned in total, $145 million. This represented about 18% of the 1997 biotechnology revenues. The Maritimes provinces accounted for only 4% of total biotechnology revenues (Table 4).

4.3 Total R&D Expenditures and Biotechnology Expenditures

In 1997, total R&D expenditures by the 282 biotechnology firms amounted to $926 million, which represents a significant percentage of the BERD (Service bulletin, vol. 25, # 4). Fifty three percent of these came from large biotechnology firms, as compared to 33% for small firms and about 18.5% for medium ones. In sum, large firms spent almost as twice as much as medium firms. Small firms outspent the latter by more than 1.5 times.

More than 79% of these expenditures in R&D were incurred by the health sector. That amounted to $733 million in R&D spending and represented about 8 times more than the R&D expenses by the agriculture and food processing sector and 17.5 times more than those by the environment sector. The total amount spent in R&D by the Other sector, i.e. firms in bio-informatics, aquaculture, mining, energy, petroleum, chemicals and forest products was $57 million, which represented roughly 6% of total R&D expenditures by the core biotechnology firms in 1997 (Table 4).

Firms in Quebec and Ontario spent almost the same amount on R&D in 1997: $363 million for firms in Ontario and $383 million for those in Quebec. Together, these two provinces accounted for about 81% of total R&D expenses by the core biotechnology firms. They are followed by British Columbia which spent $88 million on R&D. Altogether, firms in the prairies spent 77 million on R&D as compared to $14 million for the Maritimes (Table 4).

In 1997, the total amount of biotechnology R&D expenses was $494 million, or 53% of total R&D expenses incurred by the biotechnology firms. Small firms outspent other firms. They spent $193 million as compared to $177 million and $124 million for large and medium firms, respectively.

The health sector is the most engaged in biotechnology R&D with $409 million in spending, or roughly 83% of the total biotechnology expenses. It outspent the agriculture

and food processing sector by more than 7.5 times, the environment sector by more than 40 times, and the Other sector by roughly 19 times (Table 4).

As in the case for total R&D expenses, firms in Quebec and Ontario spent the most on biotechnology R&D, with Ontario leading the way with $220 million and Quebec with $132 million. British Columbia followed with $77 million. The Prairies accounted for $51 million, and the Maritimes for $14 million (Table 4).

Table 4:Total Revenues, Biotechnology Revenues, Total R&D and Total Biotechnology R&D for the Biotechnology Firms According to the Firm Size, the Sector and the Province, 1997

Firm Size, 1997	Total Revenues (000,000)	Biotechnology Revenues (000,000)	Total R&D Expenses (000,000)	R&D Biotechnology Expenses (000,000)
Small Firms (50 or less employees)	1,756	214	307	193
Medium Firms (51-150 employees)	685	201	171	124
Large Firms (over 150 employees)	12,011	398	448	177
Total	**14,452**	**813**	**926**	**494**

Sector, 1997	Total Revenues (000,000)	Biotechnology Revenues (000,000)	Total R&D Expenses (000,000)	R&D Biotechnology Expenses (000,000)
Health	3,397	417	733	409
Agriculture and Food Processing	9,792	322	93	53
Environment	1,090	49	42	10
Other	173	25	57	22
Total	**14,452**	**813**	**926**	**494**

Province, 1997	Total Revenues (000,000)	Biotechnology Revenues (000,000)	Total R&D Expenses (000,000)	R&D Biotechnology Expenses (000,000)
British Columbia	118	47	88	77
Alberta	248	56	28	20
Saskatchewan	5,644	56	35	19
Manitoba	1,908	33	14	12
Ontario	2,665	363	364	220
Quebec	3,805	224	383	132
Maritimes	61	34	14	14
Canada	**14,452**	**813**	**926**	**494**

Source: Statistics Canada

V EXPORTS ACTIVITIES

5.1 Number of Biotechnology Firms Declaring Exports and Biotechnology Exports

As may be seen in Table 5, 97 firms or 71% of the 136 exporting firms declared exporting biotechnology products. Seventy four of these were small firms, 15 were medium firms and 8 were large firms. In other words, 77% of the small exporting firms were exporting biotechnology products as compared to 68% of medium exporting firms and 44% of large exporting firms.

The bulk of the biotechnology products and exporting firms, i.e. 40 firms, were in the health sector, 19 were in agriculture and food processing, 14 were in environment and 24 were in the Other sector. Put differently, 42% of all biotechnology exporting firms were in the health sector as compared to 20% for agriculture and food processing, 14% for the environment and 25% for the Other sector.

Twenty nine (29) of the 43 Ontario exporting firms were involved in biotechnology products exports. This number was 25 for Quebec, 11 for the Maritimes and 17 for British Columbia (Table 5).

As also shown by figures in Table 5, 136 of the 282 biotechnology firms undertook some export activities in 1997. Ninety six (96) small firms declared exporting products as compared to 22 medium firms and 18 large firms. This translates into 45% of small firms, 59% of medium firms and 58% of large firms who were involved in exporting activities.

The health sector led the way with 55 firms. It was followed in decreasing order by Agriculture and food processing with 32 firms, the Other sector with 30 firms, and the environment sector with 19 firms.

Ontario and Quebec are home to the largest number of firms declaring exports, 43 and 39 firms, respectively. British Columbia had 20 firms that exported. The Maritimes had 12 exporting firms as compared to 22 for the Prairies.

Table 5: Number of Biotechnogy Firms Reporting Exports, Biotechnology Exports According to the Firm Size, the Sector and the Province, 1997

Firm Size, 1997	Total Exporting Firms	Biotechnology Exporting Firms
Small Firms (50 or less employees)	96	74
Medium Firms (51-150 employees)	22	15
Large Firms (over 150 employees)	18	8
Total	**136**	**97**

Sector, 1997	Total Exporting Firms	Biotechnology Exporting Firms
Health	55	40
Agriculture and Food Processing	32	19
Environment	19	14
Other	30	24
Total	**136**	**97**

Province, 1997	Total Exporting Firms	Biotechnology Exporting Firms
British Columbia	20	17
Alberta	11	10
Saskatchewan	7	...
Manitoba	4	...
Ontario	43	29
Quebec	39	25
Maritimes	12	11
Canada	**136**	**97**

Source: Statistics Canada

...: Figures not available

5.2 Total Export Revenues and Biotechnology Export Revenues

The total export revenues amounted to over $3.3 billion in 1997. Large firms accounted for over $2.3 billion, small firms for $810 million, and medium firms for $183 million.

The agriculture and food processing sector earned $2 billion in export revenues, the environment sector, $750 million, the health sector, $484 million and the Other sector, $24 million.

Firms in Quebec and Manitoba led the way with a little over $1 billion in export revenues for each province. Ontario and Saskatchewan followed with $540 million and $441 million, respectively. Firms in Alberta recorded $52 million in export revenues, those in British Columbia, $26 million, and those in the Maritimes, $26 million (Table 6).

Of the $3.3 billion of export revenues, $311 million or 9% came from the sales of biotechnology products and processes sales. The bulk came from large firms, $167 million or 54% of total biotechnology export revenues. Small and medium firms accounted for $67 million and $77 million, respectively.

The health sector was the largest biotechnology export revenues earner with $177 million, followed by the agriculture and food processing sector, $101 million. Environment and the Other sector contributed $24 and $9 million, respectively.

The province of Ontario accounted for $153 million or 49% of total biotechnology products and processes export revenues. That was more that 2.5 times the contribution of firms in Quebec, $59 million. Twenty four million dollars of the export revenues in British Columbia were biotechnology related, as compared to $53 million for the Prairies and $22 million for the Maritimes (Table 6).

Table 6: Total Export Revenues, Biotechnology Export Revenues, for the Biotechnology Firms According to the Firm Size, the Sector and the Province, 1997

Firm Size, 1997	Total Export Revenues (000,000)	Biotechnology Export Revenues (000,000)
Small Firms (50 or less employees)	810	67
Medium Firms (51-150 employees)	183	77
Large Firms (over 150 employees)	2,338	167
Total	**3,331**	**311**

Sector, 1997	Total Export Revenues (000,000)	Biotechnology Export Revenues (000,000)
Health	484	177
Agriculture and Food Processing	2,073	101
Environment	750	24
Other	24	9
Total	**3,331**	**311**

Province, 1997	Total Export Revenues (000,000)	Biotechnology Export Revenues (000,000)
British Columbia	26	24
Alberta	52	49
Saskatchewan	441	2
Manitoba	1,130	2
Ontario	540	153
Quebec	1,116	59
Maritimes	26	22
Canada	**3,331**	**311**

Source: Statistics Canada

VI PRODUCTS PIPELINE

6.1 Number of Biotechnology Products by Sector, by Firm Size, by Province and by Stage of Development

Overall, the 282 core biotechnology firms developped a total of 8,924 biotechnology related product, most of them (80%) still at development stage and not yet to the market. The agriculture and food processing sector was dominant with 6,268 products, followed by the health sector, 1,710 products, the Other sector with 546, and the environment with 400 products (Table 7).

Medium firms accounted for 6,268 or 70% of all the total number of products. This was more than double that for small firms which accounted for 2,520 products and more than 13 times that for large firms which had 452 products at all stages of development (Table 8).

The province of Quebec accounted for 5,834 products or over 65% of all the products. Ontario had 1,475 products, about 4 times less than Quebec. British Columbia had 800 products, Saskatchewan, 324, the Maritimes, 342, Alberta 108 and Manitoba, 41 products (Table 9).

Forty one percent of the 8,924 products were in the clinical/field trail stage as compared to 39% that were under development and 20% approved or on the market (Table 7).

The health sector accounted for 943 of the products approved or on the market, the agriculture and food processing sector, 454, the Other sector, 279 and the environment, 82 (Table 7). Small firms possessed 1,040 or 59% of these products as compared to 470 for medium firms and 248 for large firms (Table 8). Ontario and Quebec were the two provinces with the largest number of products approved or on the market, 540 and 443, respectively. They were followed in decreasing order by British Columbia, 326, the Maritimes, 223, Saskatchewan, 204, Alberta, 18 and Manitoba, 4 (Table 9).

Agriculture and food processing had 3,177 products in the clinical/field trial stage. That amounted to 86% of all the products in that development stage. Two hundred and thirty four (234) of these products belonged to firms in the environment sector and 161 to the health sector (Table 7). Medium firms were the most active firm category at that stage with 3,076 products or 83% of the total. Small firms followed with 540 and large firms with only 70 products (Table 8).

Firms in Quebec accounted for 3,090 or 84% of the products in the clinical/field trial stage. British Columbia and Ontario followed with 256 and 247 products, respectively. Sixty seven (67) of these products came from firms in the Prairies and 26 were from firms in the Maritimes (Table 9).

The largest number of the products under development were found in the agriculture and food processing sector. This sector accounted for 2,636 or 76% of all the products in that stage. The health sector followed with 607 products, the Other sector with 153, and the environment sector with 84 products (Table 7). Medium firms were the most active at that stage with 2,406 products or 69% of the total. Small firms had 940 products under development whereas large firms had 134 (Table 8). The province of Quebec accounted for 66% of all the products in that stage. That represented 2,300 products. British Columbia had 218 products under development as compared to 157 for the Prairies and 93 for the Maritimes (Table 9).

Table 7: Number of Biotechnology Products by Sector and Stage of Development, 1997

	Approved/ on Market	Clinical/Field Trial Stage	Under Development	Total
Health	943	161	607	**1,710**
Agriculture and Food Processing	454	3,177	2,636	**6,268**
Environment	82	234	84	**400**
Other	279	114	153	**546**
Total	**1,758**	**3,686**	**3,480**	**8,924**

Source: Statistics Canada

Table 8: Number of Biotechnology Products by Firm Size and Stage of Development, 1997

	Approved/ on Market	Clinical/Field Trial Stage	Under Development	Total
Small Firms (50 employees and less)	1,040	540	940	**2,520**
Medium Firms (51-150 employees)	470	3,076	2,406	**5,952**
Large Firms (Over 150 employees)	248	70	134	**452**
Total	**1,758**	**3,686**	**3,480**	**8,924**

Source: Statistics Canada

Table 9: Number of Biotechnology Products by Province and Stage of Development, 1997

	Approved/ on Market	Clinical/Field Trial Stage	Under Development	Total
British Columbia	326	256	218	**800**
Alberta	18	27	63	**108**
Saskatchewan	204	33	87	**324**
Manitoba	4	7	30	**41**
Ontario	540	247	689	**1,475**
Quebec	443	3,090	2,300	**5,834**
Maritimes	223	26	93	**342**
Canada	**1,758**	**3,686**	**3,480**	**8,924**

Source: Statistics Canada

6.2 Number of Products by Sector, Firm Size and Province and by Sector and Firm Size

The health sector firms from Ontario, Quebec and British Columbia accounted for the largest number of products. In fact, these three provinces accounted together for 91% of total biotechnology products: Ontario accounted for 632 products, Quebec 516 and British Columbia, 416. The prairies had 49 health products as compared to 96 for the Maritimes. The agriculture and food sector was dominated by Quebec firms with 5,243 products or 84% of total. Ontario followed with 552 products and Saskatchewan with 290. The environment sector was dominated by firms in British Columbia with 224 products. Ontario and Quebec followed as distant second and third with 77 and 53 products, respectively. The Prairies had 27 products only in that sector and the Maritimes 20. The Other sector is mostly dominated by Ontario with 215 products (Table 10).

Small firms were very active in about all the provinces: they accounted for 963 products in Ontario, 457 in Quebec, 487 in British Columbia, and 306 in Saskatchewan. Medium firms in Quebec were the most active with 5,127 products. Those in Ontario and British Columbia come as distant second and third with 344 and 313 products, respectively. Large firms had the largest number of products in Quebec and Ontario: 250 and 168 products, respectively (Table 11).

Small firms are the dominant force in the health sector, the environment and the Other sector. They accounted for respectively 1,005, 334 and 397 products in these sectors. The medium firms were the largest player in agriculture and food processing with 5,288 products as compared to 784 for small firms and 198 for large firms. Large firms had fewer products than any other firm category. This holds true across sectors (Table 12).

Table 10: Total Number of Biotechnology Products by Sector and Province

	Sector, 1997				
	Health	Agriculture and Food Processing	Environment	Other	Total
British Columbia	416	81	224	79	800
Alberta	14	82	5	8	108
Saskatchewan	18	290	16	0	324
Manitoba	17	18	6	0	41
Ontario	632	552	77	215	1,475
Quebec	516	5,243	53	22	5,834
Maritimes	96	...	20	223	341
Canada	**1,710**	**6,268**	**400**	**546**	**8,924**

Source: Statistics Canada

...: Figures not available

Table 11: Total Number of Biotechnology Products by Firm Size and Province

	Firm Size, 1997			
	Small Firms (50 or less employees)	Medium Firms (51-150 employees)	Large Firms (Over 150 employees)	Total
British Columbia	487	313	0	800
Alberta	86	6	16	108
Saskatchewan	306	13	5	324
Manitoba	31	4	6	41
Ontario	963	344	168	1,475
Quebec	457	5,127	250	5,834
Maritimes	191	144	6	341
Canada	**2,520**	**5,952**	**451**	**8,924**

Source: Statistics Canada

Table 12: Total Number of Biotechnology Products by Sector and Firm Size

	Sector, 1997				
	Health	Agriculture and Food Processing	Environment	Other	Total
Small Firms (50 or less employees)	1,005	784	334	397	2,520
Medium Firms (51-150 employees)	477	5,288	55	132	5,952
Large Firms (Over 150 employees)	228	198	10	15	451
Total	**1,710**	**6,268**	**400**	**546**	**8,924**

Source: Statistics Canada

VII HUMAN RESOURCES

7.1 Total Employment by the Biotechnology Firms

As may be seen in Table 13, biotechnology firms employed almost 32,000 people in 1997. Quebec accounted for about 41% of that number or about 13,000 employees. Ontario had 9,272 employees and Saskatchewan came third with 4,980 employees. Manitoba and British Columbia followed with 1,763 and 1,220 employees, respectively. Alberta and the Maritimes had less than a thousand employees each.

The largest number of employees was in large firms. They employed 19,960 people, or about 63% of total employees. Small firms employed over 8,000 people whereas medium firms had half as many (Table 14).

The health sector was the largest employer with over 13,000 people. The agriculture and food processing sector followed with 10,671 employees. The environment sector accounted for 4,388 employees (Table 15).

7.2 Biotechnology Employment

Of the 31,924 people employed by the biotechnology firms, 9,019 or 28% were biotechnology employees. The largest number of these were employed by firms in Ontario at 3,416 and Quebec at 2,722 employees. The other important biotechnology employers were British Columbia with a little over a thousand employees and, the Prairies with 1,349 employees. There were as 490 biotech employees in the Maritimes (Table 13).

Large firms accounted for 3,825 or 42% of biotech employees, medium firms for 2,299 and small firms for 2,895 (Table 14). The health sector had 6,280 employees, or about 70% of all biotechnology employees. The agriculture and food processing sector was a distant second with 1,542 employees. The environment sector followed with 291 employees (Table 15).

Table 13: Total Number of Employees,Total Number of Biotechnology Employees by Province

Province, 1997		
	Total Number of Employees	**Total Number of Biotechnology Employees**
British Columbia	1,220	1,042
Alberta	955	789
Saskatchewan	4,980	351
Manitoba	1,763	209
Ontario	9,272	3,416
Quebec	12,983	2,722
Maritimes	751	490
Canada	**31,924**	**9,019**

Source: Statistics Canada

Table 14: Total Number of Employees,Total Number of Biotechnology Employees by Firm Size

Firm Size, 1997		
	Total Number of Employees	**Total Number of Biotechnology Employees**
Small Firms (50 and less employees)	8,314	2,895
Medium Firms (51-150 employees)	3,650	2,299
Large Firms (over 150 employees)	19,960	3,825
Total	**31,924**	**9,019**

Source: Statistics Canada

Table 15: Total Number of Employees,Total Number of Biotechnology Employees by Sector

Sector, 1997		
	Total Number of Employees	**Total Number of Biotechnology Employees**
Health	13,438	6,280
Agriculture and Food Processing	10,671	1,542
Environment	4,388	291
Other	3,427	906
Total	**31,924**	**9,019**

Source: Statistics Canada

VIII OBSTACLES TO BIOTECHNOLOGY COMMERCIALIZATION

8.1 Main Biotechnology Commercialization Obstacles

Access to capital is a major obstacle to commercializing biotechnology in Canada. In fact, 118 of the 282 biotechnology firms, i.e. 42% were faced with this problem in 1997. Access to skilled human resources and the time requirements for gaining regulatory approval are also important issues confronting Canadian biotech firms. These issues affected 32% of them. Consumer acceptance, higher cost for gaining regulatory approval, the access to technology and the lack of information about markets are other important obstacles biotech firms face in selling their products. Intellectual property (IP) protection, limited international harmonization and labeling are a concern to very few of biotech firms (Table 16).

8.2 Obstacles to Biotechnology Commercialization by Sector, Firm Size and Province

Access to capital remains the greatest concern among the firms across sectors: in fact, 58 or 43% of the firms in the health sector found it to be a major obstacle to commercializing their products in 1997. This figure is 39% for the agriculture and food processing sector and 52% for the environment sector (Table 17). Access to skilled human resources and the time requirements for gaining regulatory approval are the second and third major obstacles to biotech sales in the health sector. High cost and the time required for gaining regulatory approval were cited as serious obstacles by firms in the agriculture and food processing sector, as compared to consumer acceptance, access to smart capital and time required to gain regulatory approval by the environment sector (Table 17).

Access to capital hampers biotech products commercialization for 94 or 44% of the small firms. A little over a third of them find access to skilled human resources and the time requirement for gaining regulatory approval to be major obstacles to selling their products. Other major issues for small firms are access to smart capital and the high cost of gaining regulatory approval. These problems affect over a quarter of them. The lack of information about markets and consumer acceptance hinder biotech sales for over 1 in every 5 biotech small firms (Table 18). Medium-sized firms, on the other hand, are faced primarily with access to skilled human resources, consumer acceptance and access to capital (Table 18). As for large firms, the main obstacles to biotech sales are access to capital and the time required to gain regulatory approval (Table 18).

The major hurdle to biotech sales facing firms in Ontario and Quebec is access to capital. Additional issues for firms in Quebec are access to skilled human resources and the time required to gain regulatory approval. In Ontario, firms have to deal with problems of access to smart capital and consumer acceptance. In British Columbia, the major obstacles to biotech sales are access to skilled human resources, access to capital, and time required to gain regulatory approval. In the Maritimes, the cost of gaining regulatory approval is the main issue, while the lack of information about market and access to smart capital was cited in Alberta and in Saskatchewan, limited international harmonization time required to gain regulatory approval. (Table 19).

Table 16: Commercialisation Problems Facing Biotechnology Firms in Canada

	Total Number of Firms
Access to Capital	118
Access to Smart Capital	67
Access to Technology	51
Skilled Human Resources	89
Consumer Acceptance	69
Lack of Information about Markets	59
Labelling	12
Limited International Harmonization	32
IP Protection	29
Cost for Gaining Regulatory Approval	66
Time Required to Gain Regulatory Approval	90
Other	23

Source: Statistics Canada

Table 17: Commercialisation Problems Facing Biotechnology Firms in Canada, by Sector

	Health	Agriculture and Food Processing	Environment	Other	Total
Access to Capital	58	29	16	15	**118**
Access to Smart Capital	31	13	9	14	**67**
Access to Technology	24	17	5	5	**51**
Skilled Human Resources	55	18	6	10	**89**
Consumer Acceptance	26	19	12	12	**69**
Lack of Information about Markets	29	16	6	8	**59**
Labelling	...	9	0	0	**12**
Limited International Harmonization	12	20	0	0	**32**
IP Protection	15	9	...	...	**29**
Cost for Gaining Regulatory Approval	28	27	6	5	**66**
Time Required to Gain Regulatory Approval	41	27	9	13	**90**
Other	9	6	...	5	**23**

Source: Statistics Canada

...: Figures not available

Table 18: Commercialisation Problems Facing Biotechnology Firms in Canada, by Firm Size

	Small Firms (50 and less employees)	Medium Firms (51-150 employees)	Large Firms (over 150 employees)	Total
Access to Capital	94	13	11	118
Access to Smart Capital	57	8	...	67
Access to Technology	34	8	9	51
Skilled Human Resources	71	14	4	89
Consumer Acceptance	50	14	5	69
Lack of Information about Markets	51	6	...	59
Labelling	5	4	...	12
Limited International Harmonization	22	5	5	32
IP Protection	17	7	5	29
Cost for Gaining Regulatory Approval	55	4	7	66
Time Required to Gain Regulatory Approval	70	11	10	90
Other	20	0	...	23

Source: Statistics Canada

...: Figures not available

Table 19: Commercialisation Problems Facing Biotechnology Firms in Canada, by Province

	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	Maritimes	Canada
Access to Capital	22	7	8	...	32	40	6	118
Access to Smart Capital	9	9	4	0	25	18	...	67
Access to Technology	7	...	...	...	20	12	...	51
Skilled Human Resources	24	5	5	4	21	28	...	89
Consumer Acceptance	12	4	5	...	25	13	8	69
Lack of Information about Markets	6	9	6	...	16	15	5	59
Labelling	...	...	0	0	4	...	...	12
Limited International Harmonization	...	...	9	0	13	7	...	32
IP Protection	5	...	0	...	9	10	...	29
Cost for Gaining Regulatory Approval	15	4	6	0	21	11	10	66
Time Required to Gain Regulatory Approval	21	...	9	...	22	28	8	90
Other	4	...	...	...	6	7	...	23

Source: Statistics Canada

...: Figures not available

IX PURPOSES OF RAISING FINANCING CAPITAL AND ITS SOURCES

9.1 Purposes of Raising Financing Capital

In 1997, a total of 109 firms or roughly 39% of the core biotech firms raised financing capital. By far, the need for R&D funds was the main reas : 75 out of 109 firms or 69% acknowledged raising capital for that purpose. Twelve percent (12%) raised funds for process scaleup. Raising capital for regulatory approval, was not reported by a large number of firms (Table 20).

For the 1998 year, 158 or 56% of the biotech firms intended to raise some financing capital, an increase of 31% over 1997. This trend is the same for R&D where 104 firms (as compared to 75 for 1997) intended to raise funds to conduct R&D. Fifteen firms acknowledged the need to raise financing capital for regulatory approval in 1998 as

compared to 5 in 1997. Thirty four firms want to do so for process scaleup, an increase of 61% over 1997 (Table 20).

9.2 Sources of Financing Capital

The 109 firms that raised financing capital in 1997 relied heavily on private placement and venture capital and labor sponsored funds: over 1 in three of these firms got their funds from the first source; over 1 in every 5 got funds from the latter. Twelve firms got some funds from friends/"angel investors" and eleven from strategic alliance partners (Table 21). Initial public offering (IPO) were not among the most used sources of financing capital. Indeed, very few firms used that source to get capital funds (Table 21).

The number of firms willing to get capital funds from venture capital/labor sponsored funds rose from 25 in 1997 to 40 in 1998. Capital from private placements went from 43 to 50. Strategic partners accounted as sources for 41 firms in 1998 as compared to 12 in 1997 (Table 21). Only 8 firms intended to raise funds by an IPO.

Table 20: Purposes for Raising Financing Capital by Biotechnology Firms, 1997, 1998

	1997	1998
R&D	75	104
Regulatory Approval	5	15
Process Scaleup	13	34
Other	16	5
Total	**109**	**158**

Source: Statistics Canada

Table 21: Sources of Financing Capital Raised by Biotechnology Firms, 1997, 1998

	1997	1998
Friends/"Angel Investors"	11	12
Ventured Capital/Labor Sponsored Funds	25	40
Private Placement	43	50
Initial Public Offering (IPO)	...	8
Secondary Public Offering	7	...
Strategic Alliance Partner	12	41
Other	9	5
Total	**109**	**158**

Source: Statistics Canada

...: Figures not available

X SOCIAL CAPITAL: NETWORKING ACTIVITIES

10.1 Strategic Alliances and Origin of Partners

In the survey questionnaire, an alliance is defined as "*a formal agreement with another firm to do business without merging*". As is apparent in Table 22, marketing and distribution constitute the major reason for entering strategic alliances: half of the biotechnology firms had such an agreement in 1997. Manufacturing was a reason to enter an alliance for 73 or over a quarter of the biotech firms, whereas financial reasons helped create 41 alliances, and regulatory purposes, 26.

Canada and the USA are equally important to biotechnology firms in entering strategic alliances: 94 firms had Canadian partners and 92 had American partners. Sixty four had partners in the European Union, 40 had theirs in Asia. Sixteen firms entertained South/Latin American partnerships (Table 22).

10.2 R&D Partnerships and Origin of Partners

R&D partnerships is an agreement with another organisation to undertake collaborative R&D projects. R&D partners may include other biotech companies, other companies, universities, hospitals, research institute, Canadian federal and/or provincial laboratories and, network of Canadian centres of excellence. Universities constitute very popular R&D partners for Canadian biotech firms. In 1997, 149 or over half of entertained R&D partnerships occured with these institutions. Research Institutes and other biotechnology companies were partners with 98 and 87 biotech firms, respectively. Other R&D partners include Canadian federal labs which had partnership relations with 66 firms, other companies had 57 core biotech firms as partners, 51 were partners with hospitals and, 42 entertained partnerships with Canadian network of centers of excellence. Canadian provincial labs were partners with 22 biotech firms.

Canada is by far where most of the R&D partners of the biotech firms are found: 184 or over 65% of them had R&D partners in Canada. The U.S.A. came second with 91 firms having American partners against 57 who had partners in countries of the European community. Asia and South/Latin America totaled 11 partnerships (Table 23).

Table 22: Purposes of Strategic Alliances and Origin of Biotechnology Firms' Strategic Partners, 1997

Purposes of Alliance	Number of Firms*
Marketing/Distribution	142
Manufacturing	73
Regulatory Affairs	26
Finance	41
Other	11

Origin of Strategic Partners	Number of Firms*
Canada	94
U.S.A.	92
European Union	64
Asia	40
South/Latin America	16
Other	17

Source: Statistics Canada

* The total number of firms is more than 282 because some firms have multiple partners in multiple locations

Table 23: R&D Partnerships Entertained by Biotechnology

Type of Partners	Number of Firms*
Biotechnology Company	87
Other Company	57
University	149
Hospital	51
Research Institute	98
Federal Lab (Canadian)	66
Provincial Lab (Canadian)	22
Network of Centers of Excellence (Canadian)	42

Origin of R&D Partners	Number of Firms*
Canada	184
U.S.A.	91
European Union	57
Asia	5
South/Latin America	6
Other	10

Source: Statistics Canada

* The total number of firms is more than 282 because some firms have multiple partners in multiple locations

References

Arundel, A. and Rose A.. " The diffusion of environmental biotechnology in Canada: adoption strategies and cost effects". Technovation (19), 1999.

Arundel, Anthony. Diffusion of biotechnologies in Canada. Research paper #6, SIEID, Statistics Canada, 1999.

BIOTECANADA. Canadian Biotechnology '98: Success from Excellence, 1999

Gouley, John and Deepika Nath. Canadian Biotech '97: Coming of Age. Ernst & Young, 1997

Haynes, Fred. Canadian Biotechnology 1998. Contact Canada. 1997.

McNiven, Chuck. Biotechnology Use and Development – 1999. Research paper, SIEID, Statistics Canada, 2001a.

McNiven, Chuck. Practices and Activities of Canadian Biotechnology Firms: Results from the Biotechnology Use and Development Survey - 1999.

Niosi, Jorge. Explaining Rapid Growth in Canadian Biotechnology Firms. Research paper, SIEID, Statistics Canada, 2000.

Rose, Antoine. Biotechnology use by Canadian Industry-1996. Research paper , SIEID, Statistics Canada, 1998.

Service Bulletin, Science Statistics, vol. 25 (4), 2001.

Annex 1 – Questionnaire

Science and Technology Redesign Project

Biotechnology Firm Survey - 1997

Confidential when completed.

Collected under the authority of the Statistics Act, Revised Statutes of Canada, 1985, Chapter S19.

Si vous préférez ce questionnaire en français, veuillez appeler à frais virés au (613) 951-9662.

In all correspondence concerning this questionnaire, please quote this four-digit reference number

Please correct name and address, if necessary

Purpose

Statistics Canada is undertaking this survey under the sponsorship of Industry Canada and BIOTECanada to produce information of use to firms engaged in biotechnology activities by adressing the following question: What are the main characteristics of the firms which choose to develop biotechnologies as an important component of their business? The information from the survey can be used by businesses for market analysis, by trade associations to study performance and other characteristics of their industries, by government to develop national and regional economic policies, and by other users involved in research or policy making. Statistics Canada will create a database combining survey responses with existing Revenue Canada and Statistics Canada records.

Confidentiality

While participation in this survey is voluntary, your cooperation is important to ensure that the information collected in this survey is as accurate and as comprehensive as possible. Statistics Canada is prohibited by law from publishing or releasing, in any manner, any statistics which would divulge information obtained from this survey that relates to any identifiable business without the previous written consent of that business. The data reported on the survey questionnaire will be treated in strict confidence, used for statistical purposes and released in aggregated form only. The confidentiality provisions of the Statistics Act are not affected by either the Access to Information Act or any other Legislation.

Biotechnology Definition

Biotechnology is defined as the application of science and engineering in the direct or indirect use of living organisms or parts of organisms in their natural or modified forms in an innovative manner in the production of goods and services or to improve existing processes.

Please report only on Canadian biotechnology activities of your company. Complete a separate questionnaire for each company engaged in biotechnology activities in Canada.

Questions?

If you require assistance in the completion of this questionnaire or have any questions regarding this survey please contact Lloyd Lizotte (tel: 613-951-2188 (call collect), fax: 613-951-9920 or e-mail: lizollo@statcan.ca)

Survey Contact

Please indicate the name of the person completing this form so we know who to contact should we have questions about this report.

Name	Title
Telephone Number	Fax Number
___-___-____	___-___-____

Combined Report

1. If your records do not permit separate reporting, list the names of other companies included in this report and indicate whether they are engaged in biotechnology activities by writing YES or NO in the second column.

Name of company	Biotechnology activities YES or NO	Indicate type of affiliation with reporting company (i.e. parent, subsidiary or other)
	1 ◯ Yes 2 ◯ No	
	1 ◯ Yes 2 ◯ No	
	1 ◯ Yes 2 ◯ No	
	1 ◯ Yes 2 ◯ No	
	1 ◯ Yes 2 ◯ No	

5-4900-40 1 1998-03-05 STC/SAT-465-75092

Biotechnologies used by your firm

2. Please review the following list of biotechnologies, and check the applicable circle for each technology.

Biotechnologies	Currently Used in Operations?	IF "YES" ➤ Principal Use *(check one only)*			IF "NO" ▼ Do you PLAN TO USE within 3 years?
		Products/ Processes Development	Clinical/ Field Trials	Current Production	
DNA Based					
Genetic Engineering	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
Gene Probes	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
Bio-informatics / Genomics / Pharmacogenetics	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
DNA Sequencing / Synthesis / Amplification	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
Gene Therapy	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
Biochemistry / Immunochemistry Based					
Vaccines / Immune Stimulants / Drug Design & Delivery / Combinatorial Chemistry	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
Diagnostic Tests / Antibodies	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
Peptide / Protein Sequencing or Synthesis	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
Cell Receptors / Cell Signalling / Pheromones / Three Dimensional Molecular Modelling / Structural Biology	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
Biosensors	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
Biomaterials	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
Microbiology / Virology / Microbial Ecology	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
Bioprocessing Based					
Cell / Tissue / Embryo Culture & Manipulation	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
Fermentation / Bioprocessing / Biotransformation / Bioleaching / Biopulping / Biobleaching / Biodesulphurization	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
Extraction / Purification / Separation	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
Bioremediation / Phytoremediation / Biofiltration / Bioindicators	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
Natural Products Chemistry	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
Others (Please specify)					
_____	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
_____	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No
_____	1 Yes ➤ / 2 No	1	2	3	1 Yes 2 No

If your company does not presently use or plan to use any of the biotechnologies listed above, please stop here. Sign and return questionnaire. Thank you for your cooperation.

BIO-INDUSTRY SECTOR

3. a) Please indicate the top 3 bio-industry sectors, where applicable, in numbered order, that best describe your firm's biotechnology activities, (use 1 for the Most important and 3 for the least important). Please also indicate the number of products based on genetic engineering (rDNA) your company has in each of the relevant development stages:

Human Health - Bio

1) **Diagnostics** (e.g. immunodiagnostics, gene probes, biosensors)
2) **Therapeutics** (e.g. vaccines, immune stimulants, biopharmaceuticals, rational drug design, drug delivery, combinatorial chemistry)
3) **Gene Therapy** (e.g. gene identification, gene constructs, gene delivery)

Bio-Informatics

4) **Genomics and Molecular Modelling** (e.g. DNA/RNA/protein sequencing & databases for humans,plants, animals and microorganisms)

Ag - Bio

5) **Plant Biotechnology** (e.g. tissue culture, embryogenesis, genetic markers, genetic engineering)
6) **Animal Biotechnology** (e.g. diagnostics, therapeutics, embryo transplantation, genetic markers, genetic engineering)
7) **Biofertilizers/Biopesticides/Bioherbicides/ Biological Feed Additives/Microbial pest control** (e.g. bacteria, fungi, yeasts)
8) **Non-Food Applications of Agricultural Products** (e.g. fuels, lubricants,commodity and fine chemical feedstocks, cosmetics)

Food Processing

9) **Bioprocessing** (e.g. using enzymes and bacteria culture)
10) **Functional Foods/Nutriceuticals** (e.g. probiotics, unsaturated fatty acids)

Aquaculture

11) **Fish health** (e.g. diagnostics, therapeutics)
12) **Broodstock genetics** (e.g. tracking superior traits, genetic modification / engineering)
13) **Bioextraction** (e.g. karageenan from seaweed, antifreeze proteins from fish, flavours)

Mining/Energy/Petroleum/Chemicals

14) **Microbiologically enhanced petroleum/mineral recovery**
15) **(Cleaner) Industrial Bioprocessing** (e.g. biodesulphurization, bio-cracking, bio-recovery)

Forest Products

16) **Silviculture** (e.g. ectomycorrhizae, tissue culture, somatic embryogenesis, genetic markers, genetic engineering)
17) **(Cleaner) Industrial Bioprocessing** (e.g. biopulping, biobleaching, biological prevention of sapstain)

Environment

18) **Biofiltration** (e.g. treatment of organic emissions to air/water)
19) **Bioremediation and Phytoremediation** (e.g. cleanup of toxic waste sites using microorganisms)
20) **Diagnostics** (e.g. detection of toxic substances using bioindicators, biosensors, immunodiagnostics)

Other

21) **Custom synthesis- chemical or biological** (e.g. peptides, proteins, nucleotides, hormones, growth factors, biochemicals
22) **Other** (please specify)

Top Bio-sectors (1 to 3 by importance) Please write number and sub-headings from above list	Number of products by development stages		
	Approved/ On Market (number)	Clinical/Field Trial stage (number)	Under development (number)
1			
2			
3			

b) Did you implement a new or significantly improved **PROCESS** in the last 3 years that required the development of biotechnologies?

1 ◯ Yes ➤ How many? Number

2 ◯ No

c) Do you **PLAN** to implement in the NEXT 3 years a new or significantly improved **PROCESS** that requires the development of biotechnologies?

1 ◯ Yes ➤ How many? Number

2 ◯ No

Financial Information

4. **Total Business Activity (All activities including Biotech)**

a) Is your firm a public company? 1 ◯ Yes 2 ◯ No

b) Please report data for 1997 or the latest fiscal year available.
Do not include sales and operations of your **subsidiaries** located outside Canada.

Fiscal year (if different from 1997)

Balance Sheet	1997
Cash & securities	000$
Total Assets	000$
Total liabilities	000$
Shareholders Equity	000$

Revenue	1997
Product sales	000$
Contract Research	000$
Other revenue	000$

Expenses	1997
R&D	000$
All other expenses	000$

TOTAL Exports (as % of product sales)	%
Biotechnology Related Exports (as % of product sales)	%

Total exports to the United States (as % of product sales)	%
Total exports to Europe (as % of product sales)	%
Total exports to Asia (as % of product sales)	%
Total exports to South/Latin America (as % of product sales)	%
Total exports to other countries (as % of product sales)	%

Total number of employees (average for the year):			
What percentage of your product sales are based on biotechnology?	%	OR bio product sales	000$
What percentage of your R&D expenses are based on biotechnology?	%	OR bio R&D	000$

R&D

5. a) Did your firm have biotech R&D expenditures in any of the years 1995-1997?
1 ◯ Yes
2 ◯ No

b) In the past 5 years, did your company apply for the tax benefit under the R&D (SR&ED) tax programme?
1 ◯ Yes ➤ What was the most recent year?
2 ◯ No ➤ Why did your company not apply? *(check most important only)*
1 ◯ complexity of the application process
2 ◯ uncertainty of eligibility
3 ◯ did not meet eligibility requirements
4 ◯ other *(specify)*

Strategic Partnerships

6. Does your firm currently have any strategic alliances with other organizations *(a strategic alliance is a formal agreement with another firm to do business activities without merging)*

Strategic Alliance for:		Canadian Partner	Foreign Partner, (Please identify country of partner)				
			USA	E.U	Asia	South/ Latin America	Other
Marketing/Distribution	1 Yes ➤ 2 No	1	2	3	4	5	6
Manufacturing	1 Yes ➤ 2 No	1	2	3	4	5	6
Regulatory Affairs	1 Yes ➤ 2 No	1	2	3	4	5	6
Finance	1 Yes ➤ 2 No	1	2	3	4	5	6
Other	1 Yes ➤ 2 No	1	2	3	4	5	6
R&D Partnership:							
Biotech Company	1 Yes ➤ 2 No	1	2	3	4	5	6
Other company	1 Yes ➤ 2 No	1	2	3	4	5	6
University	1 Yes ➤ 2 No	1	2	3	4	5	6
Hospital	1 Yes ➤ 2 No	1	2	3	4	5	6
Research Institute	1 Yes ➤ 2 No	1	2	3	4	5	6
Federal Lab (Canadian)	1 Yes 2 No						
Provincial Lab (Canadian)	1 Yes 2 No						
Network of Centres of Excellence (Canadian)	1 Yes 2 No						

Human Resources engaged in Biotechnology Activities

7. a) In your current biotechnology activities, please give the number of employees on staff in the listed positions (include contract personnel and use fractions of a person-year if individuals are filling more than one role).

Position	Number Now Employed	Positions Unfilled Now	Estimated Number Employed in year 2001
R&D			
Clinical Affairs/Quality Assurance			
Regulatory/Legal/Government Affairs			
Manufacturing			
Marketing & Sales			
Business Development/Finance			
Administration/Human Resources			

Human Resources engaged in Biotechnology Activities (continued)

7. b) Does your firm have a formal employee development program (continuing education and training program)?

1 ◯ Yes ➤ If yes, estimate your firm's total expenditures on formal education and training in 1997? ($000) or as a percentage of product sales

2 ◯ No

$000 $ _____ OR _____ %

c) Does your firm employ co-op program students from universities?

1 ◯ Yes

2 ◯ No

d) Do you have a full time person solely responsible for Human Resources in your organization?

1 ◯ Yes

2 ◯ No

e) What is your approximate professional staff turnover rate (persons leaving as a % of total staff) for the biotechnology activity in 1997?

_____ %

f) Are you experiencing problems in recruiting Business Operations staff?

1 ◯ Yes ➤ If YES. In which specialties?
- 1 ◯ Finance
- 2 ◯ Marketing
- 3 ◯ Regulatory, Legal
- 4 ◯ Clinical Affairs

2 ◯ No

g) Are you experiencing problems in recruiting Technical / Production / Scientific / R&D staff?

1 ◯ Yes ➤ If YES. In which specialties?
- 1 ◯ Scientist
- 2 ◯ Engineering
- 3 ◯ Technicians

2 ◯ No

h) Have you tried to hire personnel from outside Canada in 1997?

1 ◯ Yes

2 ◯ No

If Yes, From which areas?

1 ◯ US

2 ◯ EU

3 ◯ Asia

4 ◯ South/Latin America

5 ◯ Other

If Yes, were you successful?

1 ◯ Yes

2 ◯ No ➤ If No, Was the problem related to the following issues?
- 1 ◯ Personal income taxes
- 2 ◯ Immigration Rules
- 3 ◯ Advancement opportunities
- 4 ◯ Other

Intellectual property (IP) instruments

8. a) Have you ever had to abandon an important biotech project because further work was blocked by IP rights held by another organization?

1 ◯ Yes ➤ Was this an issue of scope of patent in Canada as compared to other countries? 1 ◯ Yes 2 ◯ No

2 ◯ No

b) Has your firm been involved in litigation related to patent infringement in the past year?

1 ◯ Yes ➤ How many different cases? ____

2 ◯ No

c) During the last three years has your firm assigned the right to use intellectual property **TO**: *(check where applicable)*

	In Canada	Outside Canada
Another firm	1 ◯	2 ◯
Government lab	3 ◯	4 ◯
University	5 ◯	6 ◯
Hospital	7 ◯	8 ◯

d) During the last three years has your firm acquired the right to use intellectual property **FROM**: *(check where applicable)*

	In Canada	Outside Canada
Another firm	1 ◯	2 ◯
Government lab	3 ◯	4 ◯
University	5 ◯	6 ◯
Hospital	7 ◯	8 ◯

Problems for Biotechnology Commercialization in Canada

9. Select **the three** issues that you consider are the most important problems to successfully commercialize your biotechnology products/processes:

01 ☐ Access to capital

02 ☐ Access to smart capital (money plus management expertise)

03 ☐ Access to technology

04 ☐ Skilled human resources

05 ☐ Consumer acceptance

06 ☐ Lack of information about markets

Regulations:

07 ☐ Labeling

08 ☐ Limited international harmonization

09 ☐ IP protection

10 ☐ Cost for gaining regulatory approval

11 ☐ Time required to gain regulatory approval

12 ☐ Other *(please specify)* _____

Financing

10. a) Did you raise capital in 1997 for biotechnology?

1 ◯ Yes ➤ How Much? _____ 000$

2 ◯ No

For what purposes?
(check most important)

1 ◯ R&D
2 ◯ Regulatory approvals
3 ◯ Process Scaleup
4 ◯ Other

Sources?
(check most important)

1 ◯ Friends / "Angel Investors"
2 ◯ Venture Capital / Labour Sponsored Funds
3 ◯ Private Placement
4 ◯ IPO (Initial Public Offering)
5 ◯ Secondary Public Offering
6 ◯ Strategic Alliance Partner
7 ◯ Other

b) Are you planning to raise capital in 1998?

1 ◯ Yes ➤ How Much? _____ 000$

2 ◯ No

For what purposes?
(check most important)

1 ◯ R&D
2 ◯ Regulatory approvals
3 ◯ Process Scaleup
4 ◯ Other

Sources?
(check most important)

1 ◯ Friends / "Angel Investors"
2 ◯ Venture Capital / Labour Sponsored Funds
3 ◯ Private Placement
4 ◯ IPO (Initial Public Offering)
5 ◯ Secondary Public Offering
6 ◯ Strategic Alliance Partner
7 ◯ Other

Strategic Decisions

The following question should be answered by the CEO of your company.

11. As the CEO, what were the most important decisions you made over last year (1997)? For this year (1998)?
(check up to three for each year)

	1997	1998
Refocused current product development	01 ◯	02 ◯
Downsized the organization	03 ◯	04 ◯
Increased the size of the organization	05 ◯	06 ◯
Entered product trials	07 ◯	08 ◯
Launched new product	09 ◯	10 ◯
Acquired a company	11 ◯	12 ◯
Acquired by a company	13 ◯	14 ◯
Outsourced to others	15 ◯	16 ◯
Licenced in technology	17 ◯	18 ◯

	1997	1998
Licenced out technology	19 ◯	20 ◯
Alliances with academia	21 ◯	22 ◯
Alliances with government	23 ◯	24 ◯
Alliances with companies	25 ◯	26 ◯
Raised private capital	27 ◯	28 ◯
Raised public capital	29 ◯	30 ◯
Raised $ from alliance	31 ◯	32 ◯
Raised $ from sales	33 ◯	34 ◯
Borrowed $	35 ◯	36 ◯
Other *(please specify)* _____	37 ◯	38 ◯

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